The Origins of HI Clouds in Galaxy Groups: Exploring the Range of Galaxy Interactions

Katie M. Chynoweth (NRL/NRC postdoc; Kelly Holley-Bockelmann (Vanderbilt/Fisk); Emil Polisensky (NRL/University of Maryland); Glen I. Langston (NRAO)

We explore the role of galaxy interactions as an originating mechanism for HI clouds in galaxy groups. We also place observational constraints on the possibility that HI clouds are tracers of dark-matter minihalos or cold accretion of gas onto galaxies. We are able to make specific predictions for the number and properties of HI clouds associated with dark-matter minihalos with embedded HI gas by analyzing several cosmological N-body simulations.

In order to fully explore the role of galaxy interactions in the generation of HI clouds, we have observed six galaxy groups with the Green Bank Telescope. The six groups span the range of galaxy interaction strength. We present the rough metric used to quantify the strength and recency of galaxy interactions within these groups. Our results indicate that HI clouds in our detection space are most likely to be generated through recent, strong galaxy interactions. We find no evidence of HI clouds associated with dark matter halos or cold accretion.

The Sample

Most interacting

- M81/M82
- **Local Group**
- NGC 672/NGC 784
- Canes I/M94
- NGC 2403
- NGC 45

Least interacting

Results:

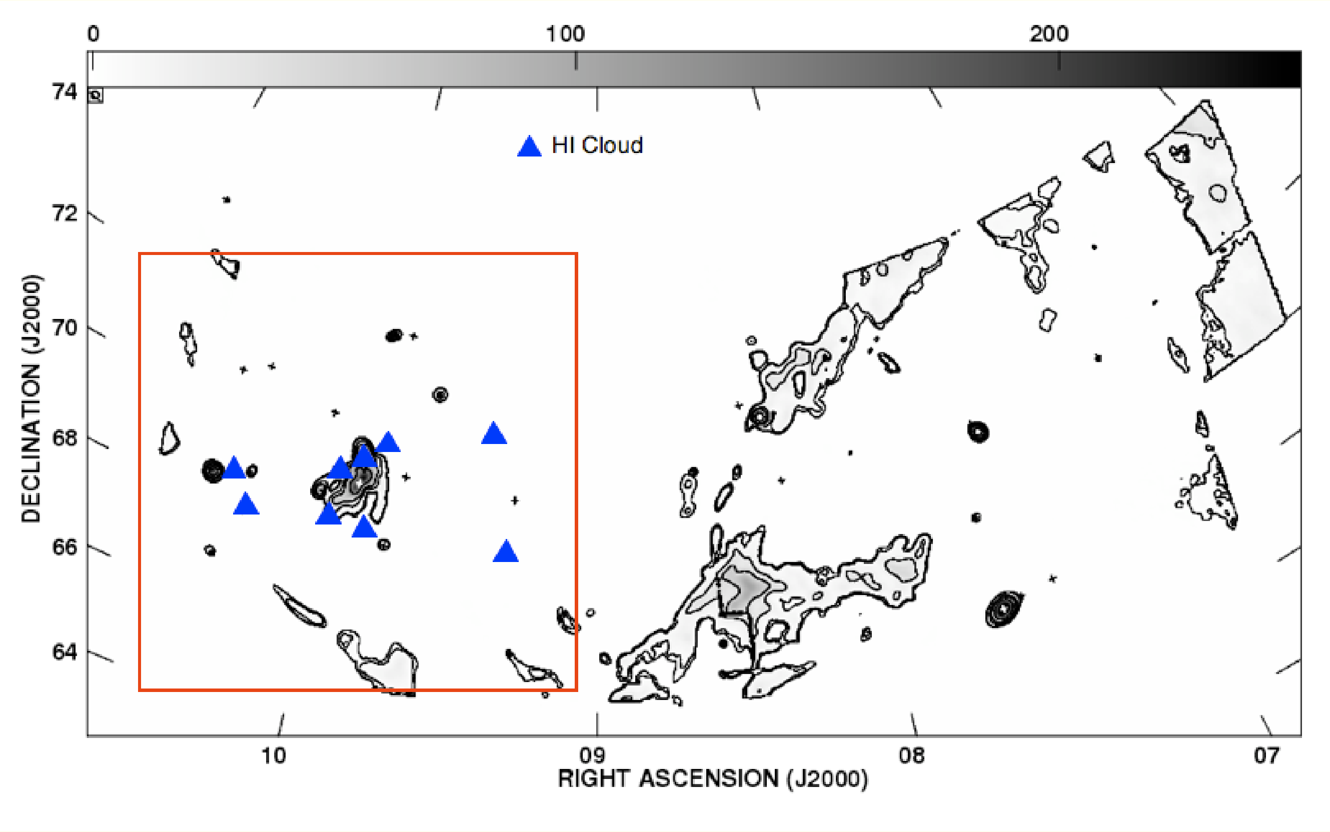
- M81/M82: 9 HI clouds
- No clouds in any other group

Ranked using:

- Galaxy group number density
- Galaxy velocities
- Galaxy morphology
- Enhanced star formation
- AGN activity

Observations:

- 330 GBT hours
- HI mass sensitivity ~ 10^6 M_{sun}
- Velocity range +/- 1000 km s^{-1}
- Area at least 50 kpc from each galaxy



katie.chynoweth.ctr@nrl.navy.mil

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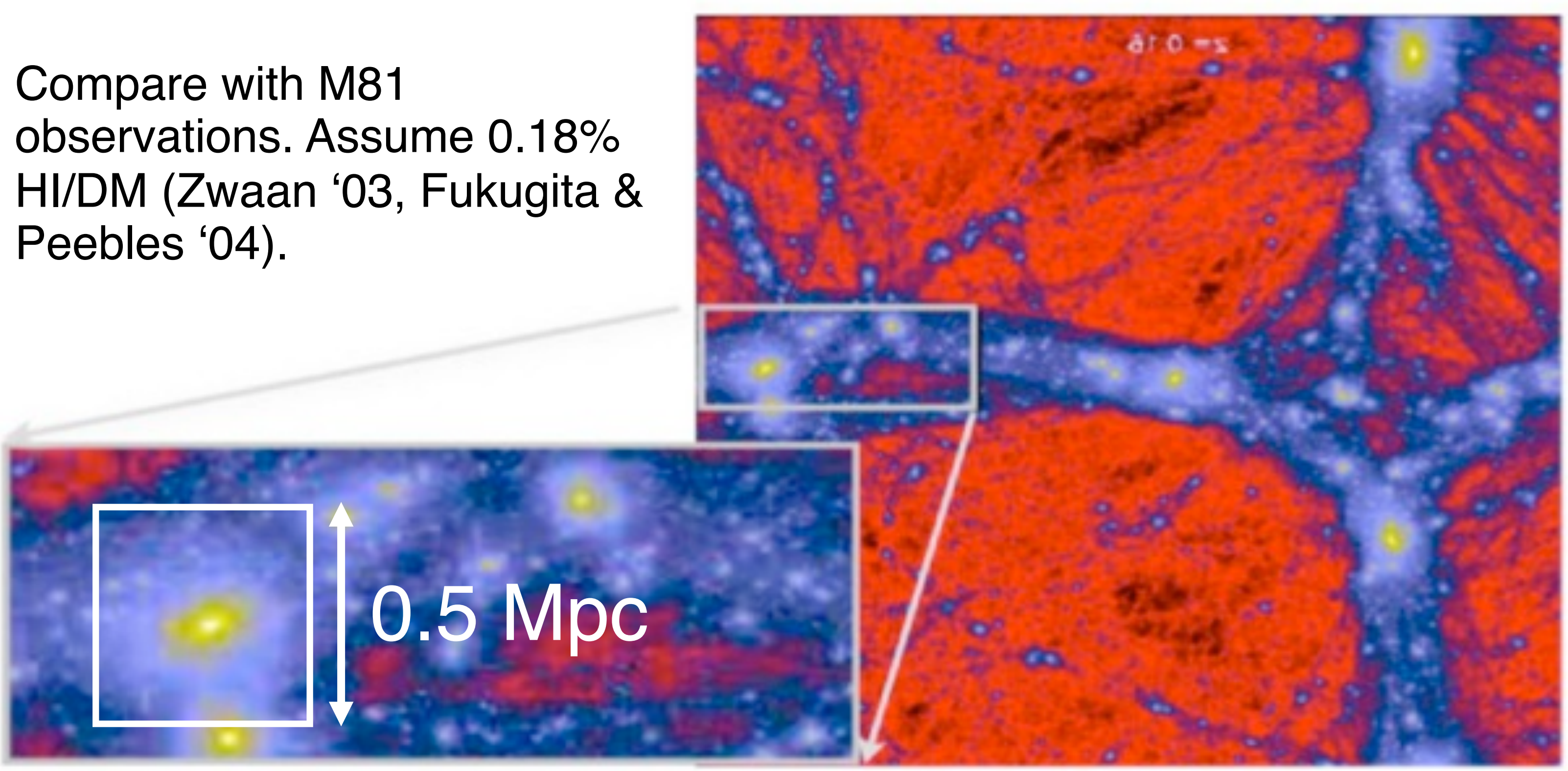
Table 17: M81 Filament H I Cloud Properties

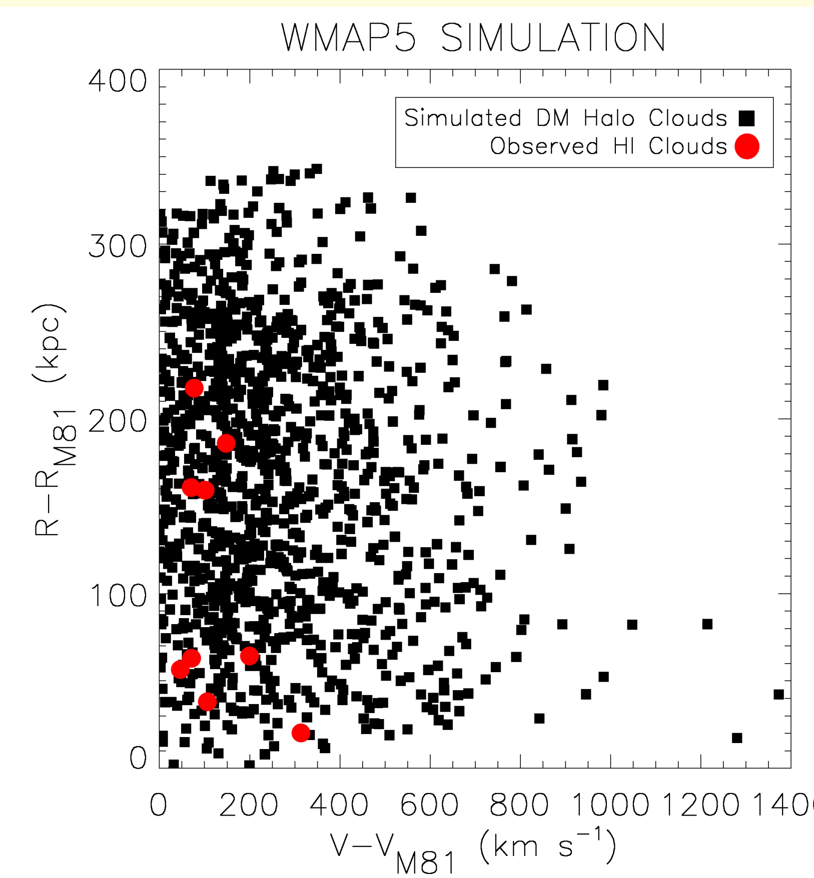
Cloud [b]	Coordinate Designation	ΔD_{M81} (kpc)	T_{peak} (K)	V_{LSR} (km s^{-1})	σ_v (km s^{-1})	M_{HI} $(\frac{D}{3.63 Mpc})^{-2}$ $\times 10^6 M_\odot$
C08-1	GBC J095007.2+695556	65	0.11	168	50	14.7
C08-2	GBC J100250.7+681949	63	0.10	-102	55	22.5
C08-3	GBC J095244.9+681250	57	0.12	14	82	26.7
C08-4	GBC J100145.0+691631	38	0.30	74	28	83.7
C08-5	GBC J095506.3+692205	21	0.07	283	36	6.9
C10-1	GBC J092635.8+702850	186	0.13	-178	57	3.6
C10-2	GBC J101926.3+675222	161	0.20	38	26	3.4
C10-3	GBC J091952.7+680937	218	0.17	-108	42	5.1
C10-4	GBC J102239.1+684057	159	0.30	69	68	12.0

[b]C08 indicates clouds from Chynoweth et al. (2008), C09 indicates clouds from Chynoweth et al. (2009), and C10 indicates clouds from Chynoweth et al. (2011).

Compare with M81 observations. Assume 0.18% HI/DM (Zwaan '03, Fukugita & Peebles '04).



Dark-matter simulation, 50^3 Mpc^3, 256^3 particles
Courtesy of K. Holley-Bockelmann



KS Test: 6% probability of same distribution